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# (54) ARTIFICIAL LIMBS

(71) We, HUGH STEEPER (ROEHAMPTON) LIMITED, a British Company, of Queen Mary's Hospital, Roehampton Lane, London, S.W.15, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to artificial limbs and is concerned more especially with artificial arms.

Various forms of artificial arm have been proposed in the past. Among these are constructions which comprise a pair of tubular members which are pivotally connected together at adjacent ends so that one member represents the upper arm, the other member represents the fore-arm, and the pivotal connection between them represents an elbow joint. It is also known to provide means for locking the two members against pivotal movement relatively to each other.

The present invention constitutes an improvement on the general construction described above, and according to the invention an artificial limb comprises first and second rigid tubular limb members pivotally connected together at adjacent ends so that the pivotal connection thus formed corresponds to the pivotal joint in a real limb, a hollow, axially-movable, non-rotatable locking plunger being located within the first limb member adjacent the said pivotal connection, the second limb member having a toothed portion rigid therewith adjacent the said pivotal connection, and the locking plunger having a nose portion adapted to lockingly engage and disengage the toothed portion as the plunger moves axially towards and away from the pivotal connection respectively, in which the plunger is spring biased for axial movement in a direction towards the pivotal connection with an operating cord being connected to the locking plunger to move the plunger in the opposite direction, and an axially-immovable, rotatable pawl of cylindrical shape is arranged for rotation within the hollow locking plunger, the pawl having a ring of axially-projecting teeth at each of its ends and the teeth each having a bevelled surface, there being a pair of inwardly-projecting pins on the hollow locking plunger arranged to strike such bevelled surfaces on the respective rings of teeth on the cylindrical pawl when the hollow locking plunger moves first in one direction and then in the opposite direction, the pawl thereby being rotated through a small arc, grooves of different depth being provided between successive teeth in one of the rings of teeth on the pawl, the said grooves being adapted to receive a respective one of the pins so that the pawl holds the nose portion of the locking plunger out of locking engagement with the said toothed portion when the said one pin on the plunger lies in a groove of one depth and allows the said nose portion to lockingly engage the toothed portion when the said one pin lies in a groove of a different depth.

An example of an artificial arm in accordance with the invention is shown in the accompanying drawings, in which:

Figure 1 is a front view of the artificial arm;

Figure 2 is a side view of the arm taken at right angles to the view shown in Figure 1 with part cut away to show a locking member;

Figure 3 is a perspective view of a small component forming part of the arm and which has been omitted from Figure 1 for the sake of clarity; and

Figures 4 to 6 are enlarged sectional views illustrating locking means forming part of the arm.

The artificial arm illustrated in the drawings comprises a pair of rigid tubular limb members 10 and 12 which are pivotally connected together at adjacent ends by a pivot pin 14 so that the pivotal connection corresponds to an elbow-joint. The tubular member 10 is here made of a light aluminium alloy and represents the upper part of the arm. The limb member 12 is likewise made of light aluminium alloy, but is of

[*Price 33p*]

smaller diameter than the tubular limb member 10, and represents the fore-arm.

It will be appreciated that, because of the pivotal joint between the two limb members 10 and 12, the lower limb member 12 will be able to swing up and down about the pivot pin 14 as indicated by the arrow in Figure 2. In order to prevent the lower limb member 12 from swinging freely about the said pivot, the member 10 is provided at or near the pivotal connection with a hollow, axially-movable, non-rotatable locking member 16 which here takes the form of a cylindrical plunger urged downwards by a spring 18 (see Figures 4—6) located within the hollow space of the locking member. A nose portion 20 of the locking member 16 is of reduced cross-section and is adapted to engage and hold fast a toothed end portion 22 on the limb member 12. In this particular case, the toothed portion 22 has a stem 24 which is located in and rigid with the remainder of the limb member 12, but the toothed portion 22 could equally well be formed integrally with the remainder of the tubular member 12. As will be seen from Figure 4, the peripheral portion of the toothed portion 22 is co-axial with the pivot pin 14. As will be understood from an inspection of Figure 4, the nose portion 20 of the locking member 16 is able to enter any selected one of the notches 26 between the teeth on the portion 22. Rotation of the locking member is prevented by a key and slot connection 17, 19 between the locking member 16 and a stationary cylindrical housing 21 mounted in the limb member 10.

A flexible cord 28 made, for example, of strong woven wire, is attached to the nose portion 20 of the locking member 16. The arrangement is such that, when the cord 28 is pulled once, it releases the locking member 16 so that the nose portion 20 is able to engage and hold fast the toothed portion 22 directly it enters one of the notches 26. If, now, the cord 28 is pulled a second time, it will move the locking member 16 clear of the toothed portion so that the two limb members 10 and 12 can pivot relatively to each other. The different effect which the first and second pulls on the cord 28 have on the locking member 16 is made possible by the provision of an axially-immovable, rotatable, cylindrical pawl 30 which turns when the locking member 16 moves in an axial direction so as to hold the locking member clear of the toothed portion 22 on every other pull on the operating cord 28. Such rotation of the pawl 30 is effected by the provision of a ring of axially-projecting teeth 31 at its upper end, a ring of axially-projecting teeth 33 at its lower end, and two inwardly-projecting pins 35 and 37 on the internal cylindrical surface 39 of the cylindrical locking member 16 which surrounds and partially houses the pawl 30. As will be seen, the teeth 31 and 33 each have inclined or bevelled upper and lower surfaces respectively. The result is that, when the locking member 16 is moved axially with respect to the pawl 30 as a result of a pull on the cord 28, the lower pin 37 will strike the bevelled surface on one of the lower teeth 33. As the locking member cannot rotate, the bevelled surface of the tooth which is struck by the pin rides over the latter and thus rotates the pawl 30 through a small arc. The pin 37 then slips into one of the grooves 43 between the teeth 33 as the locking member 16 continues its axial movement with respect to the pawl 30.

The above-described movement of the locking member 16 from its position shown in Figure 6, through the position shown in Figure 4, to the position shown in Figure 5, causes the spring 18 to be compressed. When, therefore, the pull on the cord 28 is released, the spring urges the locking member back to its original position (see Figure 6). As the locking member moves axially with respect to the pawl 30, the upper pin 35 on the locking member strikes the bevelled surface on one of the upper teeth 31. This is because the upper teeth 31 are out of alignment with the lower teeth 33. In a similar way to that described above in connection with the pin 37 and the teeth 33, the bevelled surface of the tooth struck by the pin 35 will ride over the pin and cause the pawl 30 to rotate through a small arc. The pin 35 then slips into one of the grooves 41 between the teeth 31 as the locking member 16 continues its axial movement with respect to the pawl 30.

It will therefore be seen that, each time the cord 28 is pulled and then released, the pawl 30 will be rotated through a small arc relatively to the locking member 16. As a result, the pin 35 enters the next successive groove 41 between the teeth 31 each time the cord 28 is pulled and released. Now, as shown in Figures 5 and 6, every other groove 41 between adjacent teeth 31 is of greater depth than the remaining grooves 41. In other words, one groove 41 is of shallow depth, the next groove 41 is of greater depth, the following groove 41 is of shallow depth, the next one is of greater depth, and so on. Accordingly, if the pin 35 enters a deeper groove 41, the locking member is able to travel axially through a greater distance under the pressure of the spring 18 than if the pin 35 enters a shallow groove 41. The result is that the locking member 16 takes up the locking position shown in Figure 6 whenever the pin 35 lies within a deeper groove 41, while it takes up the "raised-clear" position shown in Figure 4 whenever the pin 35 lies within a shallow groove 41.

In order to prevent the lower limb member 12 from swinging backwards (a movement which is not possible in a human arm), a stop member 32 preferably made of a material other than metal is fitted on the toothed portion 22. As will be seen in Figure 4, the stop member 32 abuts against an opposing surface on the tubular limb member 10 when the two limb members are in the "straight line" position.

As shown in Figure 1, the pivot pin 14 passes through holes in a forked end portion 34 of the upper limb member 10, the pivot pin thereby being supported by the said forked end. It will also be seen that the toothed portion 22 forms part of the pivotal connection between the two limb members 10 and 12. This arrangement permits the nose portion 20 of the locking member 16 to move in and out of an axial opening in the lower end of the limb member 10.

An artificial hand 36 is removably carried on the end of the limb member 12 remote from the pivotal connection, the thumb and fingers of the hand being pivotally mounted so that they can be operated by pulling on a cord 38 attached to them. Further, in order that the artificial arm may resemble as closely as possible a normal human arm, the limb members 10 and 12 and the pivotal connections between them are covered by a removable sleeve 40 (see Figure 1) of foamed synthetic plastics material having an external shape resembling a human arm. The synthetic plastics sleeve 40 is preferably itself covered by a flesh-coloured stocking (not shown). It has been found desirable in such a construction for the pivotal connection between the two limb members 10 and 12 to be flanked by a pair of freely-rotatable wheels 42 made of nylon or some other low friction material. Such wheels then facilitate relative pivotal movement between the two limb members 10 and 12 after the foamed synthetic plastics material 40 has been fitted over them.

In order that the cord 38 for operating the thumb and fingers of the hand 36 may be pulled easily without tearing the foamed synthetic plastics sleeve 40, a post 44 projects outwards from the limb member 12 near the pivotal connection in order to carry the cord 38.

The upper end of the limb member 10 will normally be attached in some way to a shoulder piece worn by the patient. Such a shoulder piece is shown in broken lines at 46 in Figure 1.

A small refinement to the artificial arm is illustrated in Figure 3. In order to prevent the toothed portion from biting into or becoming clogged with the synthetic plastics material of the sleeve 40, a flexible shield 48 made of synthetic plastics sheet material extends between the adjacent ends of the limb members 10 and 12. The shield 48 has a slot 50 in its lower end through which the tubular limb member 12 passes so as not to inhibit pivotal movement of the limb member 12.

The above description is concerned solely with an artificial arm, but it is to be understood that the invention is equally applicable to artificial legs. Where the construction of the invention is used in an artificial leg, the tubular member 10 will be long enough to form that part of the leg above the knee, while the tubular member 12 will form that part of the leg below the knee, the pivotal connection between the two members constituting the knee-joint in the artificial leg. An artificial foot will be fitted on the lower end of the tubular member 12 in place of the hand 36.

## WHAT WE CLAIM IS:—

1. An artificial limb comprising first and second rigid tubular limb members pivotally connected together at adjacent ends so that the pivotal connection thus formed corresponds to the pivotal joint in a real limb, a hollow, axially-movable, non-rotatable locking plunger being located within the first limb member adjacent the said pivotal connection, the second limb member having a toothed portion rigid therewith adjacent the said pivotal connection, and the locking plunger having a nose portion adapted to lockingly engage and disengage the toothed portion as the plunger moves axially towards and away from the pivotal connection respectively, in which the plunger is spring biased for axial movement in a direction towards the pivotal connection with an operating cord being connected to the locking plunger to move the plunger in the opposite direction, and an axially-immovable, rotatable pawl of cylindrical shape is arranged for rotation within the hollow locking plunger, the pawl having a ring of axially-projecting teeth at each of its ends and the teeth each having a bevelled surface, there being a pair of inwardly-projecting pins on the hollow locking plunger arranged to strike such bevelled surfaces on the respective rings of teeth on the cylindrical pawl when the hollow locking plunger moves first in one direction and then in the opposite direction, the pawl thereby being rotated through a small arc, grooves of different depth being provided between successive teeth in one of the rings of teeth on the pawl, the said grooves being adapted to receive a respective one of the pins so that the pawl holds the nose portion of the locking plunger out of locking engagement with the said toothed portion when the said one pin on the plunger lies in a groove of one depth and allows the said nose portion to lockingly engage the toothed portion when

the said one pin lies in a groove of a different depth.

2. An artificial limb according to claim 1, in which the hollow locking plunger is arranged for axial sliding movement in a stationary cylindrical housing located in the first limb member, there being a key-and-slot connection between the locking plunger and the cylindrical housing to prevent rotation of the locking plunger while permitting axial movement.

3. An artificial limb according to claim 1 or claim 2, in which the toothed portion of the second limb member has a stem by which is rigidly located in the second limb member, the toothed portion forming part of the pivotal connection between the two limb members.

4. An artificial limb according to any one of claims 1—3, in which the limb members and the pivotal connection between them are covered by a removable sleeve of foamed synthetic plastics material having an external shape resembling a human arm or leg.

5. An artificial limb according to claim 4, in which the pivotal connection between the two limb members is flanked by a pair of freely-rotatable wheels to facilitate relative pivotal movement between the two limb members after the foamed synthetic plastics sleeve has been fitted over them.

6. An artificial limb according to claim 4 or claim 5, in which the foamed synthetic plastics sleeve is itself covered by a flesh-coloured stocking.

7. An artificial arm according to any preceding claim, in which an artificial hand is removably carried on that end of the second limb member which is remote from the pivotal connection, the hand having pivotally-mounted fingers and a pivotally-mounted thumb which are operated by pulling on a cord attached to them.

8. An artificial arm or leg according to claim 7, in which a post projects outwards from the second limb member near the pivotal connection in order to carry the cord attached to the fingers and thumb of the hand.

9. An artificial arm or leg substantially as described herein with reference to the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1.

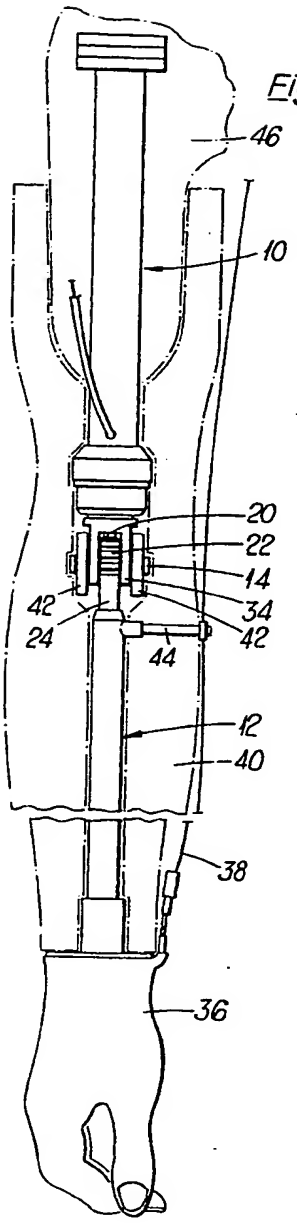



Fig. 3.

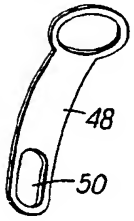
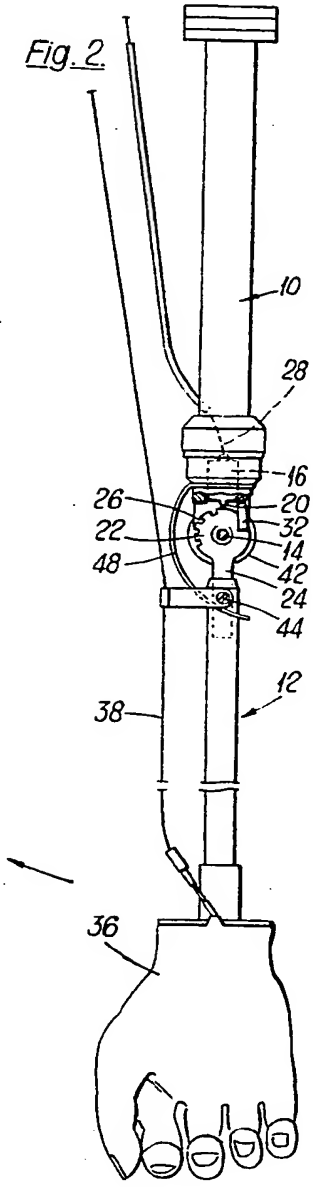



Fig. 2.



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Sheet 2

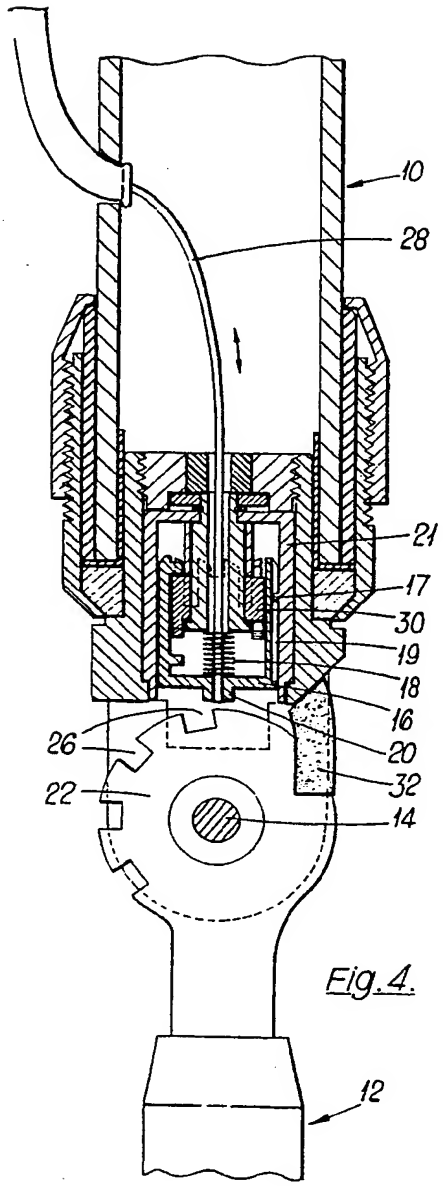


Fig. 4.

Fig. 5.

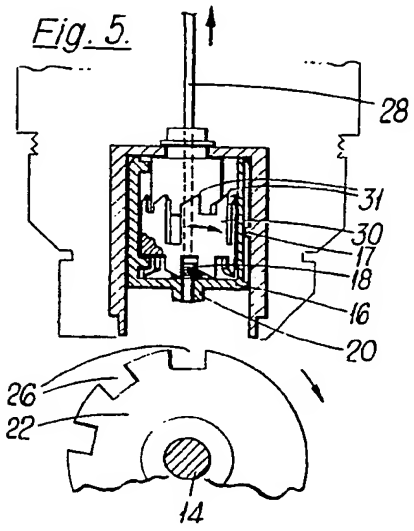


Fig. 6.